Claims

1. Connection system for conduits, fittings or assemblies which are intended for carrying a fluid acted upon by a pressure (p_1) increased with respect to a reference pressure (p_2), in particular for systems carrying carbon dioxide, comprising a first coupling part (1), such as a housing part, a second coupling part (2), such as a plug part, capable of being introduced into the first coupling part (1) along an axis (X-X), and at least one gas-permeable circumferential seal (3) which consists of an elastomer and is arranged in a groove (4) which has a groove depth (T) and a groove length (NL) and which is formed circumferentially in one of the two coupling parts (1, 2), one coupling part (2) being capable of being plugged with a shank (5) into a round receiving orifice (6) of the other coupling part (1), after plugging-in, the circumferential seal (3), while undergoing deformation and generating a radial prepressing force (F_V), sealing off a gap (7) with a gap width (s) between the outer radius (R_{SA}) of the shank (5) and the inner radius (R_{OI}) of the receiving orifice (6) and at the same time bearing against the coupling parts (1, 2) at least over a contact length (KL) running in the axial direction (X-X) perpendicularly to the respective radius (R_{SA}, R_{OI}) of the coupling parts (1, 2),
characterized in that the cross section (AU, AU_R, AU_E, AU_{opt}) of the nonpressed circumferential seal (3), the groove depth (T) and the gap width (s) and also the groove length (NL) are coordinated with one another in such a way that, in a ratio (A_E/KL), determining a permeation through the circumferential seal (3), of a permeation-active partial circumferential area (A_E) of the circumferential seal (3) to the contact length (KL), the partial circumferential area (A_E) is no greater than half the value of a cross-sectional area (A_V) of the deformed circumferential seal (3), the said

cross-sectional area running perpendicularly to the axial direction (X-X).

2. Connection system according to Claim 1, characterized in that the cross section (AU, AU_R, AU_E, AU_{opt}) of the nonpressed circumferential seal (3), the groove depth (T) and the gap width (s) and also the groove length (NL) are coordinated with one another in such a way that, in the ratio (A_E/KL), determining the permeation through the circumferential seal (3), of the permeation-active partial circumferential area (A_E) of the circumferential seal (3) to the contact length (KL), the partial circumferential area (A_E) is no greater than one fifth of the value of a cross-sectional area (A_V) of the deformed circumferential seal (3), the said cross-sectional area running perpendicularly to the axial direction (X-X).

3. Connection system according to Claim 1 or 2, characterized in that the partial circumferential area (A_E) is arranged in the vicinity of the gap (7) and is determined by an arcuate line (BL) of a pressed radial cross-sectional area (A_R) of the deformed circumferential seal (3).

4. Connection system according to Claim 3, characterized in that a length of the arcuate line (BL) assumes minimally the value of the gap width (s) in the case of a disappearing arcuate curvature and at maximum is no greater than half the value, preferably one quarter of the value, of the sum of the gap width (s) and of the groove depth (T).

5. Connection system according to one of Claims 1 to 4, characterized in that the cross section (AU, AU_R, AU_E, AU_{opt}) of the nonpressed circumferential seal (3), the groove depth (T) and the gap width (s) and also the groove length (NL) are coordinated with one another in

such a way that the permeation-active partial circumferential area (A_E) is independent of a cord thickness ($2*R_{SO}$, 2*HB) of the nonpressed circumferential seal (3).

6. Connection system according to one of Claims 1 to 5, characterized in that the size of a contact length (KL_1) between the inner radius (R_{OI}) of the first coupling part (1) and the circumferential seal (3) is dimensioned according to the equation

$$KL_1 = C1\sqrt{\frac{F_V R_{RS}}{E_D R_{OI}}},$$

C1 being a constant, F_V being the prestressing force acting in the radial direction, R_{OI} being the inner radius of the first coupling part (1), E_D being the value of the modulus of elasticity of the circumferential seal (3), and R_{RS} being a measure of the convex curvature of the seal (3), for example the cord radius (R_{SO}) of an O-ring seal (OR) in a nonpressed state.

7. Connection system according to one of Claims 1 to 6, characterized in that a degree of filling (FG) of the groove (4), calculated, taking into account the possible thermal expansion of the circumferential seal (3), as a quotient of a fraction, lying in the groove (4), of the pressed radial cross section (A_R) of the circumferential seal (3) and the cross-sectional area (A_N) of the groove (4), lies in the range of 58.0 percent to 100.0 percent, preferably of 78.0 percent to 98.0 percent.

8. Connection system according to one of Claims 1 to 7, characterized in that, in the case of an asymmetric position of the circumferential seal (3) in the groove

(4), taking into account the possible thermal expansion of the circumferential seal (3), a degree of filling (FGH) of the groove (4), calculated as a quotient of a comparatively larger fraction (A_{RH}), lying in one half of the cross-sectional area (A_N) of the groove (4), of the pressed radial cross section (A_R) of the circumferential seal (3) and of half the cross-sectional area ($A_N/2$) of the groove (4), lies in the range of 58.0 percent to 100.0 percent, preferably of 78.0 percent to 98.0 percent.

9. Connection system according to one of Claims 1 to 8, characterized in that the cross section (AU_E, AU, AU_{opt}) of the circumferential seal (3) has, in the nonpressed state, a preform, in which a quotient (FZ_U) of an axial main extent (HA) and of a radial main extent (HB) of the seal cross section has a value of greater than 1, preferably greater than 2.

10. Connection system according to one of Claims 1 to 9, characterized in that the cross section (AU_E) of the circumferential seal (3) in the nonpressed state has an elliptic form.

11. Connection system according to one of Claims 1 to 9, characterized in that the cross section (AU) of the nonpressed circumferential seal (3) is composed of two semicircular areas (KF1, KF2) or areas in the form of a segment of a circle and of a rectangular area (RF) lying between them.

12. Connection system according to one of Claims 1 to 9, characterized in that the cross section (AU_{opt}) of the nonpressed circumferential seal (3) consists in the basic configuration of a rectangle which has two longitudinal sides curved convexly with a first radius of curvature (R_1), two transverse sides curved convexly

with a second radius of curvature (R_2) and four corners rounded convexly with a third radius of curvature (R_3).

13. Connection system according to Claim 12, characterized in that the third radius of curvature (R_3) is smaller than the first radius of curvature (R_1) and the first radius of curvature (R_1) is smaller than the second radius of curvature (R_2).

14. Connection system according to one of Claims 1 to 8, characterized in that the circumferential seal (3) is formed by an O-ring (OR) with a cross section (AU_R) which is circular in the nonpressed state, in which the ratio of the inside diameter $(R)_1$ to the thickness of its cord ($2*R_{SO}$) is smaller than or equal to 6, preferably is smaller than 3, and in which a minimum pressing (VP) lies in a range of more than 15 percent, preferably of more than 25 percent to a maximum of 40 percent.

15. Connection system according to one of Claims 1 to 14, characterized in that, in the radial cross section (A_R) of the deformed circumferential seal (3), the contact length (KL) differs by less than 15 percent, preferably by less than 10 percent, particularly preferably by less than 5 percent, from a maximum axial permeation length (L_{max}) through the circumferential seal (3).

16. Connection system according to one of Claims 1 to 15, characterized in that the first coupling part (1) and/or the second coupling part (2) consists of metallic materials, in particular of aluminum alloys or highly alloyed high-grade steel alloys.

17. Connection system according to one of Claims 1 to 16, characterized in that a maximum roughness value (R_{max}) of the surfaces of the coupling parts (1, 2), at

least in the region of the outer radius (R_{SA}) of the shank (5) and of the inner radius (R_{OI}) of the receiving orifice (6), where the circumferential seal (3) comes to bear, is lower than 16 µm, preferably lower than 10 µm.

18. Connection system according to one of Claims 1 to 17, characterized in that the surfaces of the coupling parts (1, 2), at least in the region of the outer radius (R_{SA}) of the shank (5) and of the inner radius (R_{OI}) of the receiving orifice (6), where the circumferential seal (3) comes to bear, are produced by the smooth rolling of faces which, as compared with the machined surfaces, have an over dimension of 0.018 mm to 0.040 mm and a roughness (R_a) in the range of 1.6 to 3.2 µm.

19. Connection system according to one of Claims 1 to 18, characterized in that the circumferential seal (3) consists of a polymeric fluorocarbon compound, of synthetic rubber, such as silicone rubber, NBR or H-NBR, PUR, EPDM, SBR, or the like.

20. Connection system according to one of Claims 1 to 19, characterized in that the circumferential seal (3) has a Shore A hardness in the range of 70 to 90.

21. Connection system according to one of Claims 1 to 20, characterized in that two or more circumferential seals (3) are arranged one behind the other in the axial direction (X-X).

22. Connection system according to Claim 21, characterized in that an outer circumferential seal (3) accessible to the surrounding atmosphere has, due to aging, a reduced permeability coefficient (P) and an inner circumferential seal (3) protected from the

surrounding atmosphere by the outer circumferential seal (3).

23. Connection system according to one of Claims 1 to 22, characterized in that the fluid acted upon by the pressure (p_1, p_2) is carbon dioxide (CO_2).

24. Connection system according to one of Claims 1 to 23, characterized in that the pressure (p_1) acting upon the fluid lies in the range of about 10 bar to 180 bar.

25. Connection system according to one of Claims 1 to 24, characterized in that a value (Q_2) of the quantity (Q) of the fluid which has penetrated through the circumferential seal (3) as a result of permeation is no greater than about 2.5 g per year and connection, preferably no greater than 1 g per year and connection.

26. Connection system according to one of Claims 1 to 25, in particular according to one of Claims 23 to 25, characterized in that the ratio (A_E/KL) determining the permeation through the circumferential seal (3) is no greater than 50.0 mm, preferably no greater than 17.5 mm, at room temperature.

27. Connection system according to one of Claims 1 to 26, in particular according to one of Claims 23 to 26, characterized in that the ratio (A_E/KL) determining the permeation through the circumferential seal (3) is no greater than 4.5 mm, preferably no greater than 1.2 mm, at 100°C.

28. Connection system according to one of Claims 1 to 27, in particular according to one of Claims 23 to 27, characterized in that the ratio (A_E/KL) determining the permeation through the circumferential seal (3) is no greater than 1.00 mm, preferably no greater than 0.25 mm at 150°C.

29. Connection system according to one of Claims 1 to 28, characterized in that a plugging force (F_S) which can be applied for plugging-in, while the circumferential seal (3) undergoes deformation and the radial prepressing force (F_V) is generated, is, in the case of an inner radius (R_{OI}) of the first coupling part (1) in a range of about 6 mm to 13 mm, lower than 100 N, preferably lower than 50 N, particularly preferably lower than 30 N.

30. Connection system according to one of Claims 1 to 29, characterized in that the circumferential seal (3) is provided with a gas barrier coating.

31. Circumferential seal for a connection system according to one of Claims 1 to 30, characterized by one or more features of the characterizing part of Claims 9 to 13, 15, 19, 20 or 30.